14

The Interdependence of Social Science and Food Science

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The social consequences of technology development have created an active arena of litigation, with subsequent limitations on the scope of applied technology. Recourse to such terms as "size neutral" constitutes an attempt by agricultural research entities to divorce technology development from its social consequences for both small "family" farmers and large corporate enterprises; likewise for projects that focus on research (the CRSPs' mandate) rather than research plus extension—the latter is left to national programs. Again, this represents an attempt to sidestep the potential social impacts of technology development.

In the ultimate analysis, however, such rhetorical postures cannot shield either biological or social scientists from the actual consequences of technology development. Some of the chapters in this volume leave the impression that biological scientists have been antagonistic toward, or at best benignly neglectful of, social scientists. Wherever the truth may lie in such perceptions, the fact is that social impacts cannot be ignored. Perhaps an illustration from one natural scientist's perspective of where social scientists can make important contributions in agricultural development may be helpful.

A PLANT/PEOPLE MODEL OF FOOD DELIVERY SYSTEMS

An early contribution to international agricultural research came from economics, by way of what was basically an application of the second law of thermodynamics (Table 14.1) This law states that the energy available to a system equals the total energy in the system minus the unavailable energy. This simple statement has had numerous interpretations, but its essence has guided many technology development efforts. An example is the steam engine: as with many scientific innovations, the impetus to find the theoretical limits to the efficiency of this invention was primarily economic.

TABLE 14.1. AN ANALOGY OF THE SECOND LAW OF THERMODYNAMICS APPLIED TO FOOD SYSTEMS

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o $\Delta G = \Delta H - T\Delta S$

o free energy = total energy - unavailable energy

o available food = total food produced - unavailable food

o consumed food = total food harvested - food lost, wasted, or used elsewhere

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Applying this analogy of the second law of thermodynamics in food science generates the equivalent equation that "available food equals the total food produced within a system minus that lost, wasted, or used elsewhere" (Table 14.1). With this equation, a simple plant/people model of food delivery systems with sharply distinct phases can be derived, as illustrated in Figure 14.1.

As the figure shows, when seed is sown, there is no available food because no food is produced; hence, system entropy is very high. That is, the molecules of the system are widely scattered in a random fashion. During the growth period, of course, the molecules are reordered into specific ratios and alignments, and the total food produced reaches a maximum. At the same time, the randomness in the system is also reduced. Thus, at harvest time, the available food becomes positive and has value. Because of its value, it is at about this time that farmers must be on guard against crop theft - one type of loss and hence a source of system entropy.

After the harvest, the total potential for food formation is nil, and the only way to increase available food is to prevent waste. Thus, all actions from the harvest onward are concerned with preservation, utilization, and distribution mechanisms aimed at decreasing randomness. The molecules again become dispersed, and randomness is very high. The purpose of food processing is to preserve the low entropy of the food. This means preventing spoilage and waste, and maximizing availability and acceptance. The latter factors are highly dependent upon characteristics of both the food and the consumer. Information about these characteristics can be used to increase the probability of consumption (Table 14.2). With consumption, the total energy in the food system decreases.

The equation in Table 14.2 is not derived from first principles, but rather is a summation that accords with food scientists' experience. Food value is derived from such things as, first, the quantity of the food, multiplied by a factor that assesses quality and recognizes that all foods are not equivalent. The resulting value is in turn multiplied by a host of probability factors that determine the food's utilization. Of course, all of these must be reckoned per unit cost, as shown in the denominator of the equation in Table 14.2. The

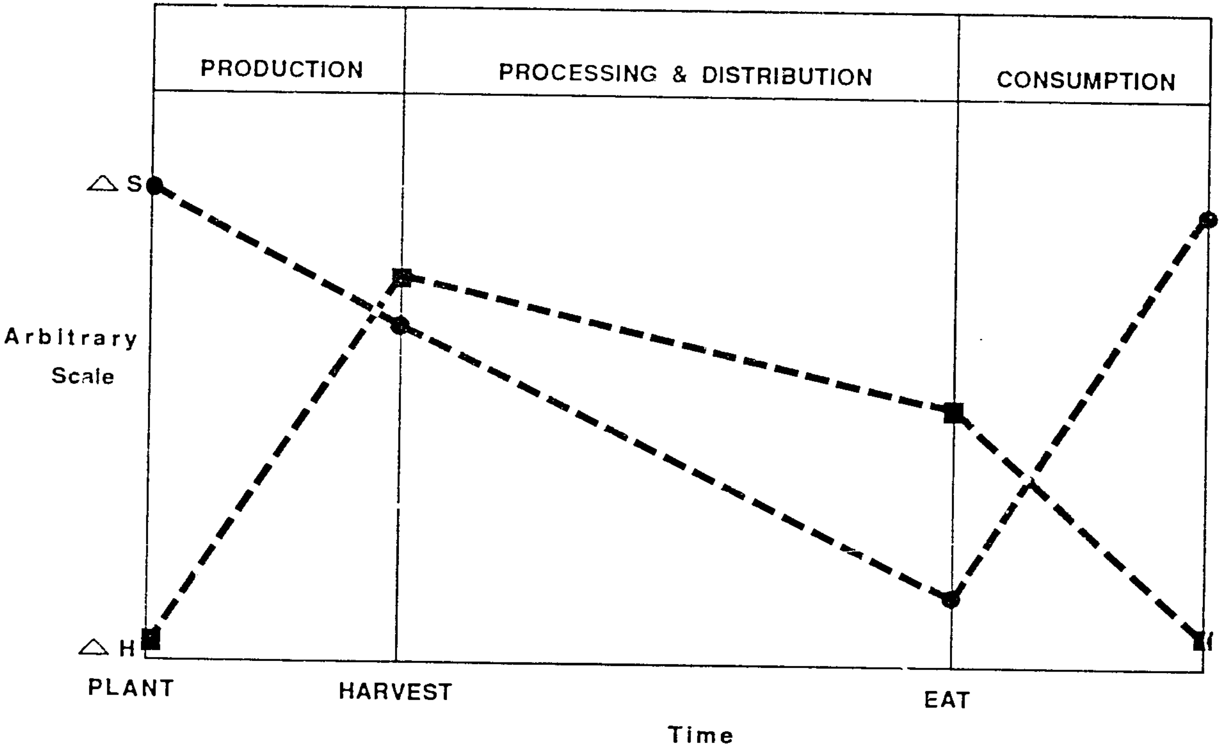

FIGURE 14.1. THE THREE PHASES OF THE FOOD DELIVERY SYSTEM

TABLE 14.2. RELATIONS AMONG ATTRIBUTES IN THE FOOD DELIVERY SYSTEM

- o value of food = [amount] X [quality] X [probability of consumption]
- o maximize for efficiency:

$$\frac{\text{value of food}}{\text{cost}} \qquad \frac{[\text{amount}] \times [\text{quality}]}{\text{cost}} \times [\text{probability of consumption}]$$

probability factors for utilization include, inter alia, the probability of sale at a certain price; the probability that the foodstuff is acceptable for social or cultural reasons; and the probability that it has the right qualities of, for example, taste and color. Because these probability factors are multiplied in the equation, if they prove to be very low any technological efforts centering on that foodstuff are all for naught. This is what is meant by such sayings as, "No food is nutritious unless it is eaten by somebody."

Food scientists primarily select out the factors involved in acceptance and endeavor to test only this probability, by way of consumer panels and other assessment techniques. They focus on this issue not because of ignorance of other factors, but because of a lack of training in how meaningfully to assess these other parameters. Food technologists must therefore seek help in these areas. Too often, they merely ignore these parameters or attempt to make such judgments themselves. This is equivalent to having social scientists act as, say, chemists. Workable solutions require the collaborative efforts of *both* natural and social scientists.

SOCIAL SCIENCE CONTRIBUTIONS

Several of the chapters in this book illustrate some of the ways that social scientists contribute to the food and nutrition sciences. DeWalt and DeWalt highlight one of the most critical messages of the social sciences for food sciences: namely, the goals of nutrition research need to be closely targeted to those in need. Moreover, these authors show how needs may differ by region and social class. In the course of their discussion, they also illustrate many of the key operational activities that social sciences can perform for and with the natural sciences, such as targeting, understanding crop and food systems and predicting impacts of new technology on food consumption, recommending improvements, and monitoring and evaluating program outcomes.

The chapter by Cattle also lays out some of the ways that social scientists can facilitate research and disciplinary integration, from the design phase forward. In field operations, for example, social science inputs are important in selecting research sites and sample populations, establishing interview techniques and policy, building a team, managing personnel, communicating among many different groups, and more. In particular, serving as guides in unfamiliar territory, social scientists can interact with local populations to enhance project operations and can translate between projects and people to the benefit of both.

Paolisso and Baksh's chapter offers an excellent example of how social science inputs can both refine focused hypothesis testing and generate new questions for food and nutrition research. Equally important is their contribution to methodological strategies in collecting and analyzing data on food systems. Expressing the effects of malnutrition in terms of social modes and behaviors, emotions, responsiveness, and other factors directly contributes to an understanding of the human consequences of technological interventions, both proposed and attempted.

However, because the results of such investigations are presented in anthropological or sociological terms, social scientists need to interpret their findings clearly for technologists. The successful communication of results and agreement on their meaning are important to efficient teamwork. Clearly, mutual respect and understanding are required. While this book demonstrates the value of bringing together diverse disciplines to explore common goals, and while much progress has been made in this regard, mutual education remains a continuing need.

As several authors point out, the inclusion of social scientists in the planning phase of projects is certainly one way to increase interdisciplinary communication and respect, and to overcome the service role that later attachment to a project tends to foster for social sciences. Working together in planning, social scientists can guide natural scientists in the applied arena with suggestions as to cost, shape, color, seasonality, social acceptability, and other factors in proposed directions in food and nutrition R&D.

Where projects have the same time frame, however, cooperation becomes a parallel effort, and thus must be continued at appropriate steps in the design and development of technology. At various points in this process, social scientists should be asked whether a given technology is socially acceptable, environmentally sound, and economically feasible. It is perhaps unrealistic to expect them to give an immediate yes or no answer to such questions; but answers as to whether the project should proceed or change direction seem reasonable. Working thus in tandem, continual input from social scientists as to the acceptability of proposed technology might be one good way effectively to deploy their skills. And since the ultimate success of any technology depends upon its social benefits, it is fitting that it be monitored and assessed by experts in this arena; the social scientists.

In sum, it is clear that social scientists have an integral role to play in the successful development of agricultural technology for the benefit of "real people." Although this volume deals with developing countries, there is a lesson to be learned here from the history of U.S. agriculture, which has evolved through the expansion of cropland, increased utilization of mechanical power, and exploitation of the production sciences. But further developments, whether in the United States or abroad, will of necessity entail increased application of the social sciences.

NOTES

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